# DRAFT

# Programmatic Environmental Assessment

**for**

## Fisheries and Ecosystem Research Conducted and Funded

by the

## Southeast Fisheries Science Center

**April 2016**

# Appendix A

## SEFSC Research Gear and Vessel Descriptions

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# 1 Trawl Nets

A trawl is a funnel-shaped net towed behind a boat to capture fish. The cod end, or 'bag,' is the fine-meshed portion of the net most distant from the towing vessel where fish and other organisms larger than the mesh size are retained. In contrast to commercial fishery operations, which generally use larger mesh to capture market-sized fish, research trawls often use smaller mesh to enable estimates of the size and age distributions of fish stocks in a particular area. The body of a trawl net is generally constructed of relatively coarse mesh that functions to gather schooling fish so that they can be collected in the codend. The opening of the net, called the 'mouth', is extended horizontally by large panels of wide mesh called 'wings.' The mouth of the net is held open (horizontally and vertically) by the hydrodynamic force exerted on the trawl doors attached to the wings of the net, floats placed on the headrope, and the net itself as the vessel moves forward.

The trawl net is usually deployed over the stern of the vessel, and attached with two cables, or 'warps,' to winches on the deck of the vessel. The cables are played out until the net reaches the fishing depth. The duration of the tow depends on the purpose of the trawl, the catch rate, and the target species. At the end of the tow, the net is retrieved and the contents of the cod end are emptied onto the deck or sorting table. For research purposes, the speed and duration of the tow and the characteristics of the net must be standardized to allow for meaningful comparisons of data collected at different times and locations. Active acoustic devices incorporated into some research vessels and trawl gear may be used to monitor the position and status of the net, speed of the tow, and other variables important to the research design.

SEFSC research trawling activities use both 'pelagic' (surface or mid-water) trawls, which are designed to operate at various depths within the water column, as well as 'bottom' trawls, which are designed to capture target species at or near the seafloor. Bottom trawls may have sweeps to collect marine animals as they lay on the bottom or gather before the trawl opening. The trawl gear may be constructed and rigged for various target species and to operate over different types of bottom surfaces.

## Aleutian Wing Trawl

The SEFSC uses an Aleutian Wing Trawl to sample mid-water prey (500-800 m) of marine mammals in the Gulf of Mexico and Atlantic Research Areas. Aleutian Wing Trawls are high speed mid-water trawls and they tend to be larger than bottom trawls with ropes that herd the shoals of fish towards the main body of the trawl (Figure A-1). The Aleutian Wing Trawl used by the SEFSC has a 10-meter (m) wide mouth opening and 2 x 3 m doors and is towed for 1-3 hours at target depth.

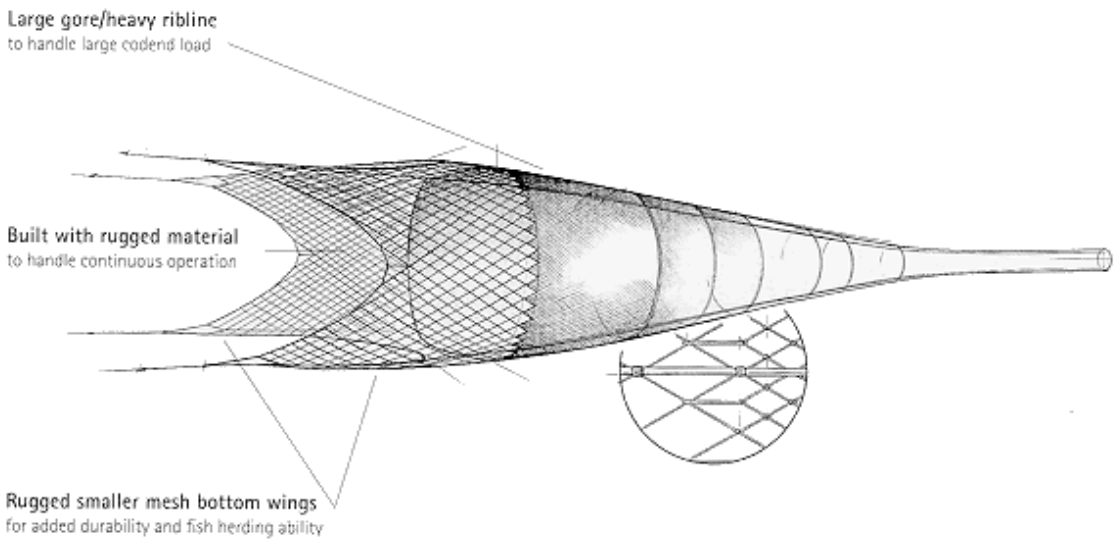


**Figure A-1. Aleutian wing trawl illustration**

## Otter Trawl

The otter trawl with various modifications, is the dominant gear used in SEFSC surveys. A basic otter trawl consists of a heavy mesh bag with wings on each side designed to funnel shrimp and fish into the cod end. A pair of otter boards or trawl doors positioned at the end of each wing hold the mouth of the net open by exerting a hydrodynamic downward and outward force at towing speed.

An otter trawl is a cone-shaped net consisting of a body (made from two, four, and sometimes more panels) and narrowing to one or two codends. Lateral mesh wings extend forward from the opening and lead to two otter boards which force the wings open by the hydrodynamic force imposed when the vessel moves forward. A boat can be rigged to tow a single or two parallel trawls from the stern or from the side on outriggers. Otter trawls usually have an extended top panel (square) to prevent fish from escaping upwards over the top of the net. The mouth of the trawl is framed by a headrope (also called a headline) with floats to open the trawl vertically and the footrope with rollers or other groundgear designed for particular sea floor conditions to maximize the capture of target species living close to the bottom and minimize damage to the gear while moving across uneven surfaces (Figures A-2 and A-3).

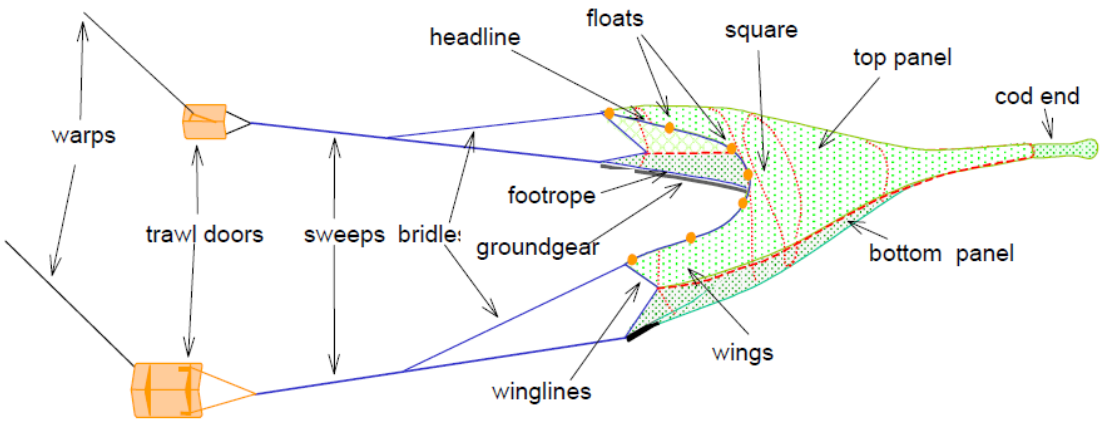


**Figure A-2. Otter bottom trawl illustration**

**Figure A-3. Otter trawl being hauled onboard**

## Semi-balloon Shrimp Trawl

The semi-balloon shrimp trawl is a modified version of an otter trawl (Figure A-4). The semi-balloon shrimp trawl used by the SEFSC consists of a 20 ft trawl net (1 ½ in stretch mesh), with 30 in wooden otter trawl doors and a tickler chain. It is used in estuaries of the Georgia Sound system that includes the Ossabaw, Altamaha, and St. Andrew rivers to develop indices for recreationally important crustaceans and finfish.

**Figure A-4. Semi-ballon shrimp trawl being deployed**

## Western Jib Shrimp Trawl

The western jib shrimp trawl is another variation of an otter trawl and is used by the SEFSC for gear testing of various Turtle Excluder Devices (TEDs). The western jib shrimp trawl is 50 feet in length with 8 foot by 40 inch wooden doors.

## Mongoose-type Falcon Bottom Trawls

The mongoose trawl is a variation of the otter trawl (Figure A-2). The mongoose design incorporates a triangular tongue of additional webbing attached to the middle of the headrope pulled by a center towing cable, in addition to the two cables pulling the doors. This configuration allows the net to spread wider and higher than the conventional otter trawl. The paired (towed by two vessels) mongoose-type Falcon bottom trawl (manufactured by Beaufort Marine Supply) is used during the SEAMAP-SA North Carolina Pamlico Sound Trawl Survey to monitor juvenile fish, shrimp, and crab abundance. This trawl is 120 ft wide with a three-lead bride, 34 ft footrope, 0.1875-inch tickler chain, and 4 x 2 ft wooden doors. A pair of 75-ft mongoose-type Falcon trawl nets are also employed by the SEAMAP-SA Coastal Trawl Survey but the paired trawl is accomplished by towing the two nets on outriggers on either side of the same vessel. This trawl has a three-lead bridle, 89-ft foot-rope, 0.25-inch tickler chain, and 10 ft x 40 inch wooden chain doors.

## Skimmer Shrimp Trawl

A skimmer trawl (Figure A-5) extends from the outrigger of a vessel with a cable and a lead weight which hold the trawl mouth open (instead of floats and chains). Skimmers are only used in shallow waters because of the way they are constructed.

The skimmer trawl is held in place by the frame on three sides and mounted on the vessel just behind the bow. Skimmer trawls are pushed through the water instead of towed behind the vessel like otter trawls. The frame is rigid enough to keep the net on the bottom but flexible enough to glide over obstacles along the bottom. This allows the skimmer vessel to continue to move while the cod end of the trawl is retrieved and emptied. This may be done as often as every 30 minutes. The skimmer trawl illustrated below includes a TED and Bycatch Reduction Device (BRD).

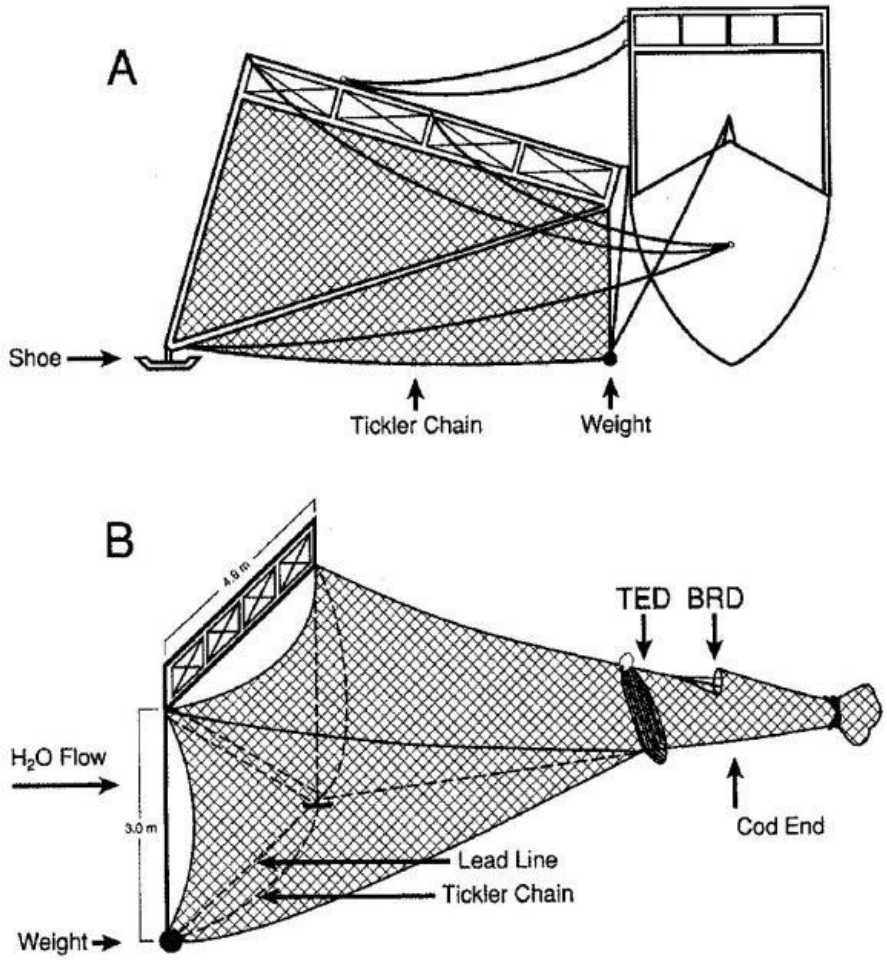


**Figure A-5. Skimmer trawl schematic**

## Miniature Roller Frame Trawl

The roller frame trawl (Figure A-6) has a rectangular rigid frame, usually metal, to keep the mouth of the net open. The interior of the frame contains a grid of vertical bars shielding the net opening, while the bottom of the frame has rollers which allow the apparatus to roll over the seabed. The beam length of the frame is not more than 16 feet and the vertical bars in the frame are no more than 3 inches apart. The SEFSC uses a miniature roller frame trawl with a 0.5 m diameter mouth and 1 mm mesh to collect pink shrimp for comparison of survival and growth.

**Figure A-6. Roller frame trawl**

## Modified Beam Trawl

A beam trawl (Figures A-7 and A-8) is a type of bottom trawl that uses a wood or metal beam to hold the net open as it is towed along the sea floor. The beam holds open the mouth of the net so that no trawl doors are needed. Beam trawls are generally smaller than other types of bottom trawls. Commercial beam trawls have beams of up to 12 meters, while beam trawls for research purposes typically use beams of two to four meters. The beam trawl used by the SEFSC for post-larval, juvenile fish, and invertebrate surveys is a modified version that is constructed with a beam of 1.5 meters and could be pulled by hand.

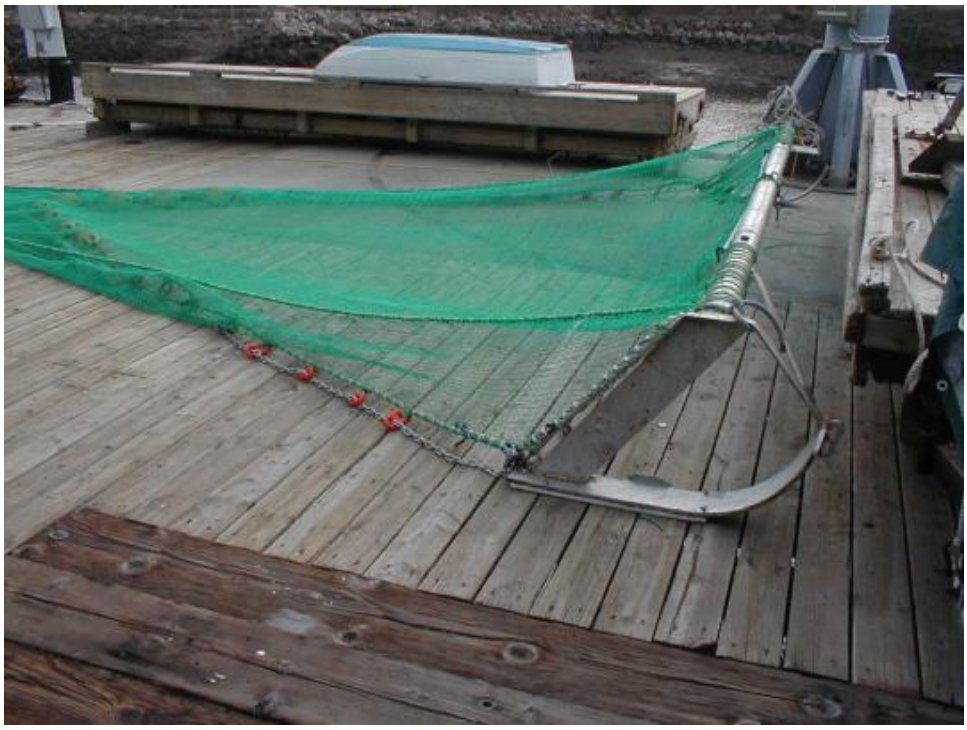

**Figure A-7. Beam trawl on deck**

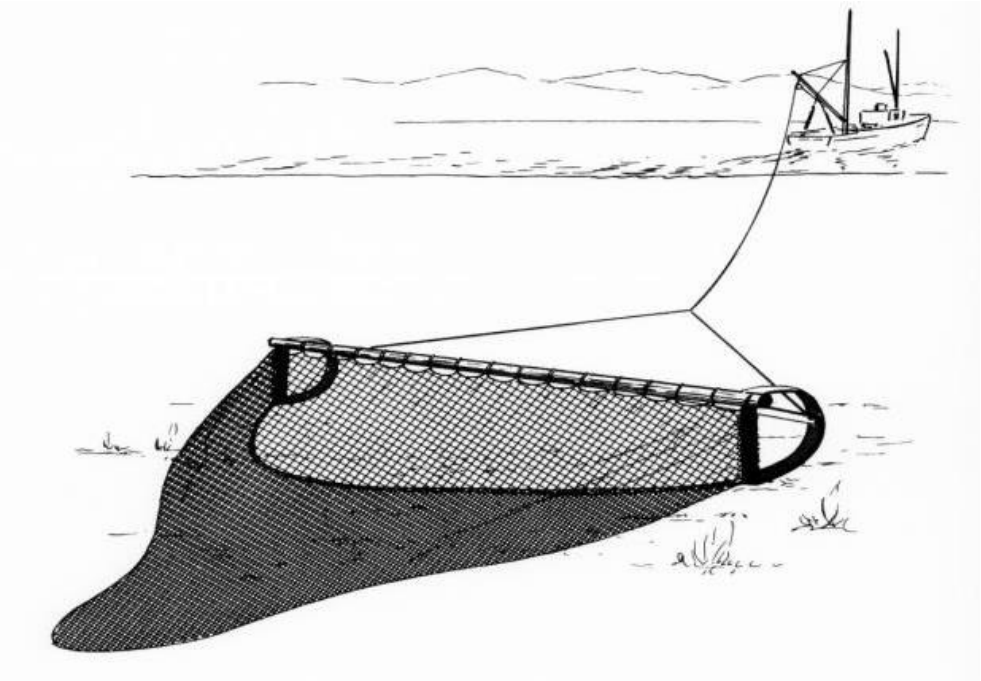

**Figure A-8. Beam trawl illustration**

# 2 Oyster Dredge

Oyster dredges (Figure A-9) are constructed from a metal frame with metal chain netting. Along the front edge of the dredge is a long bar with teeth that are dragged on the seafloor to pick up oysters and deposit them into the chain mesh netting. The oyster dredge used for the Mississippi Department of Marine Resource Oyster surveys consists of a nine-tooth bar about 20 inches wide with teeth 4 inches long and spaced 2 inches apart.

**Figure A-9. Oyster dredge**

# 3 Hook-and-Line Gear

A variety of SEFSC surveys use hook-and-line gears to sample fish either in the water column or in benthic environments. These gear types include baited hooks deployed on longlines as well as rod-and-reel and bandit gear deployments.

Longline vessels fish with baited hooks attached to a mainline or 'groundline'. The length of the longline and the number of hooks depend on the species targeted, the size of the vessel, and the purpose of the research. Hooks are attached to the mainline by another thinner monofilament line called a 'gangion'. The length of the gangion and the distance between gangions depends on the purpose of the research. The longlines used by the SEFSC for research typically have 100 gangions, each with one baited hook.

## Pelagic Longline

Buoys are used to keep pelagic longline gear suspended near the surface of the water, and flag buoys (or 'high flyers') equipped with radar reflectors, radio transmitters, and/or flashing lights are attached to each end of the mainline to enable the crew to find the line for retrieval (Figure A-10). Target species for pelagic longline surveys conducted by the SEFSC are pelagic sharks and finfish species  These pelagic

longline protocols have a five-nautical mile mainline with 100 gangions. The time period between completing deployment and starting retrieval of the longline gear is the 'soak time.' Soak time is an important parameter for calculating fishing effort and is typically three hours for SEFSC surveys. Short soak times can help reduce longline interactions with sea turtles and marine mammals.

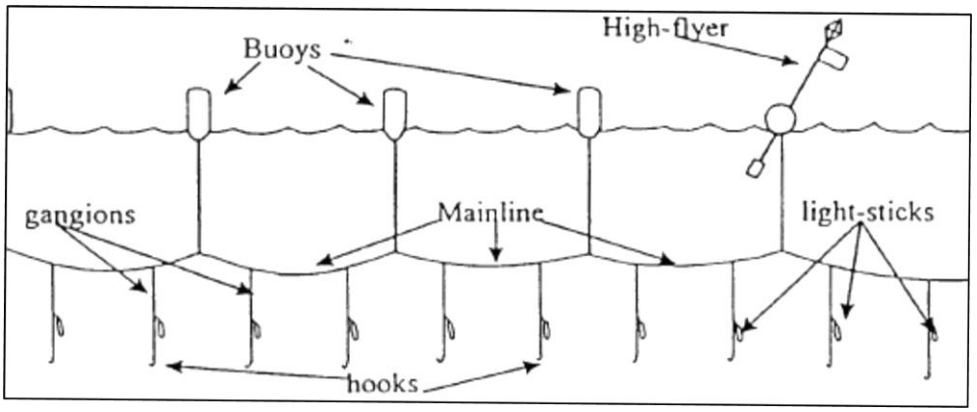


**Figure A-10. Pelagic longline schematic**

## Bottom Longline

Bottom longlines used by the SEFSC to survey species in deeper water, including sablefish, have a one-mile long monofilament mainline that is anchored on the seafloor with weights at the mid-point and ends. The line is marked at the surface by radar high flyers (Figure A-11).

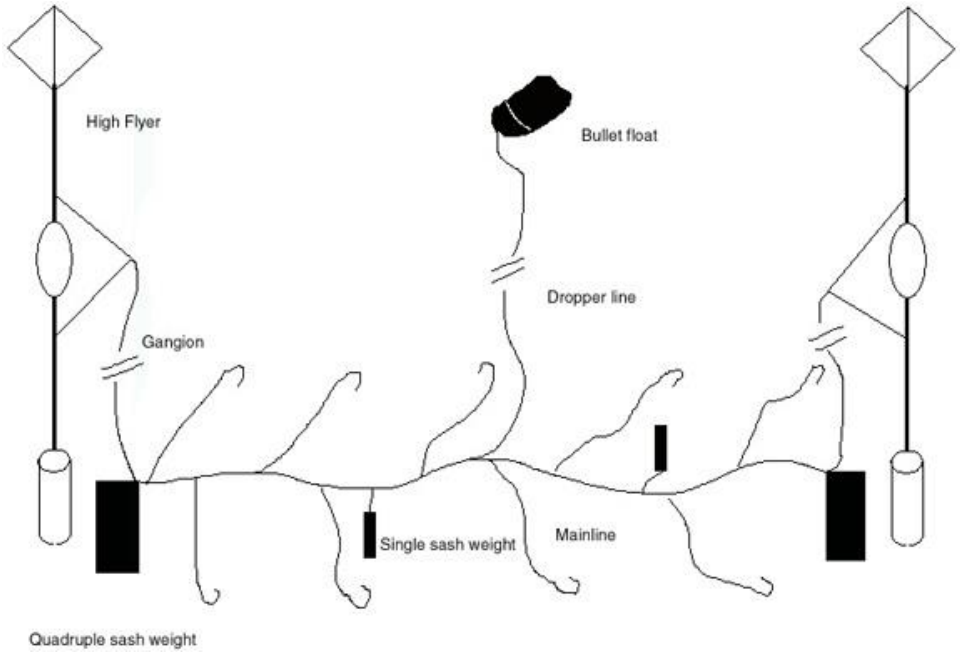


**Figure A-11. Bottom longline schematic**

## Rod and Reel

This gear is a standard fishing pole with a reel attached near the base. These are used by the SEFSC to sample fish in the nearshore reef inlet and estuary of the St. Lucie River, FL.

## Bandit Reels

Bandit reels are heavy duty fishing reels that are used for deep sea fishing (Figure A-12). The SEFSC uses a bandit reel with a vertical mainline and 10 gangions that is either deployed from the vessel and marked at the surface by a buoy or is fished while maintaining an attachment to the reel. The hook sizes used are 8/0, 11/0, or 15/0 circle hooks with 0 offset.

**Figure A-12. Bandit reel**

# 4 Plankton Nets

SEFSC research activities include the use of several plankton sampling nets that employ very small mesh to sample plankton from various parts of the water column. Plankton sampling nets usually consist of fine mesh attached to a weighted frame. The frame spreads the mouth of the net to cover a known surface area.

## Bongo Nets

Bongo nets are used by the SEFSC during various plankton surveys conducted throughout the three research areas. Bongo nets are also used to collect additional data during shark and finfish surveys. Bongo nets consist of two cylindrical nets that come in various diameters and fine mesh sizes (Figure A-13). The bongo nets are towed through the water at an oblique angle to sample plankton over a range of depths. During each plankton tow, the bongo nets are deployed to a depth of approximately 210 m and are then retrieved at a controlled rate so that the volume of water sampled is uniform across the range of depths. In

shallow areas, the sampling protocol is adjusted to prevent contact between the bongo nets and the seafloor. A collecting bucket, attached to the end of the net, is used to contain the plankton sample. When the net is retrieved, the collecting bucket can be detached and easily transported to a laboratory. Some bongo nets can be opened and closed using remote control to enable the collection of samples from particular depth ranges. A group of depth-specific bongo net samples can be used to establish the vertical distribution of zooplankton species in the water column at a site. Bongo nets are generally used to collect zooplankton for research purposes, and are not used for commercial harvest.

**Figure A-13. Bongo net**

## Neuston Nets

Neuston nets are used to collect zooplankton that lives in the top few centimeters of the sea surface (the neuston layer). This specialized net has a rectangular mouth opening (usually 2 or 3 times as wide as deep, i.e. 60 cm by 20 cm). They are generally towed half submerged at 1-2 kts from the side of the vessel on a boom to avoid the ship's wake.

**Figure A-14. Neuston net**

## Methot Juvenile Fish Net

A Methot net is used to sample juvenile fish, shrimp, and other larger plankton (4 millimeters and larger). It is a single net with a large square opening and is towed behind the vessel. A flowmeter suspended in the mouth of the net measures the flow of water moving through the net and allows for calculation of the volume of water sampled.

## MOCNESS

The Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) uses a stepping motor to sequentially control the opening and closing of individual nets to obtain discrete depth tow data (Figure A-15). The MOCNESS uses underwater and shipboard electronics for controlling the device. The electronics system continuously monitors the functioning of the nets, frame angle, horizontal velocity, vertical velocity, volume filtered, and selected environmental parameters such as salinity and temperature. The SEFSC uses the MOCNESS to develop larval indices for snapper, parrot fish, and grouper, as well as to determine seasonal abundances, and population connections between islands and upstream sources.

**Figure A-15. MOCNESS**

# 5 Other Nets

## Bag Seine

A bag seine is a seine net operated from the shore (Figure A-16). The gear is composed of a bunt (bag or lose netting) and long wings often lengthened with long ropes for towing the seine to the beach. The headrope of the net stays at the surface of the water with float attachments and the footrope maintains contact with the bottom, creating an effective barrier for fish. The SEFSC uses bag seines with a central cod end to survey shrimp, shellfish and estuary fish populations.

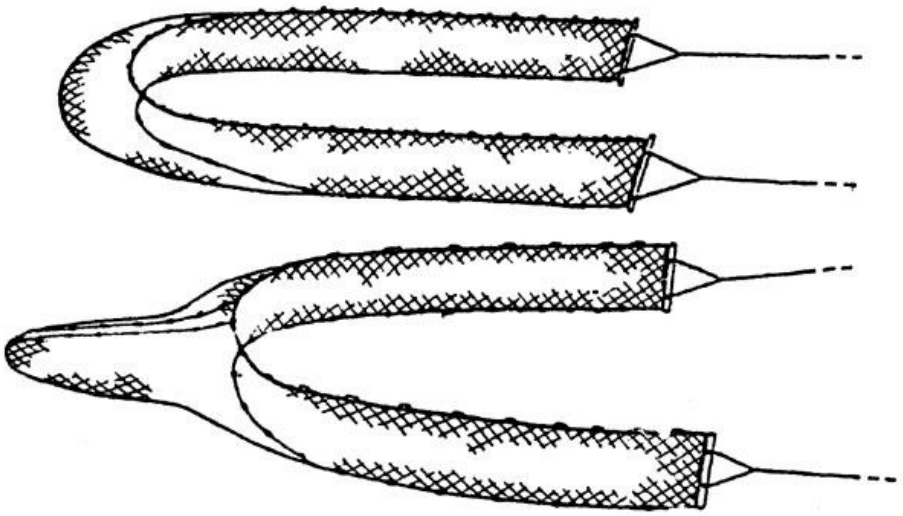

**Figure A-16. Bag seine illustration with and without a central codend**

## Set Gillnets

Set gillnets (Figure A-17) consist of vertical netting held in place, either near the surface or lower in the water column, by floats and weights to selectively target fish of a particular size range depending on the netting size (Walden 1996). Typical gillnets are made of monofilament, multi-monofilament, or multifilament nylon constructed of paneling of varying mesh sizes depending on their use and target species (Hovgård and Lassen 2000). The SEFSC uses gillnets of various sizes, ranging from 1 to 5½ inches stretched mesh, and total net lengths from 100 to 750 feet. Gillnets are used in finfish, smalltooth sawfish, and juvenile shark population surveys in the Gulf of Mexico and Atlantic.

Two SEFSC surveys have shallow water deployments in depths from 0.2 to 2 m. A single 750 ft long x 6 ft deep gillnet consisting of five 150 ft panels, each with stretch-mesh sizes 2, 2½, 3, 3 ½, and 4 inches, respectively, is used for the IJA Coastal Finfish Gillnet Survey. The Smalltooth Sawfish Abundance Survey uses gillnets that are 5 ft deep and either 100 or 200 ft long with mesh sizes either 3 or 4 inches, fished in depths of 0.2-1.0 m. Nets are anchored at both ends, and marked with surface buoys; only one net is fished at a time.

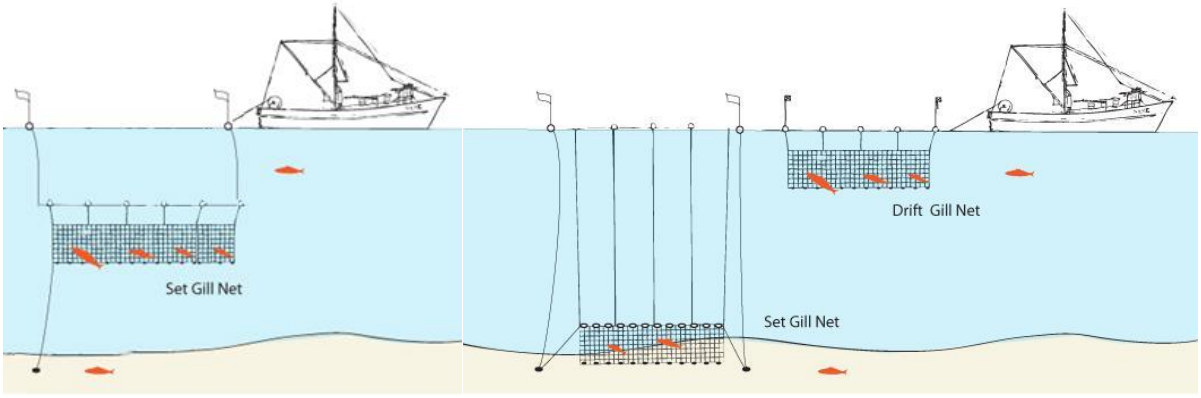


**Figure A-17. Diagram of different gillnet deployments**

## Midwater Set Gillnet

All research institutions participating in the GULFSPAN survey use a midwater monofilament set gillnet consisting of six different stretched-mesh size panels for sampling in all areas. Stretched-mesh sizes range from 3 inches to 5½ inches in ½ inch steps. Each panel is 10 feet deep and 100 feet long. Other panel specifics can be found in Baremore et al. (2012). The six panels are strung together and fished as a single gear (i.e., set); one end of each set is anchored and the opposite end is tied to the boat via a bridle.

Individual sampling strategies may differ between research institutions; however, in general, sets are chosen randomly and the gear is fished either perpendicular to shore or with the wind. It is the aim of the study to have half of the sets made in depths less than 5 meters (16 feet) and half in depths greater than 5 meters. In depths greater than 10 feet (the depth of the net), the gear acts like a midwater gillnet - the lead line weighs enough to hold the floats under the surface of the water but not enough to sink the net completely. In depth less than 10 feet, the gear fishes the entire water column. For all net configurations, the hanging ratio (length to height ratio of the meshes) is 0.5, leadline weight is 4.5 kilograms, 2.3 kilograms of buoyancy is used, and panel length is 100 feet.

Set soak time is defined from the time the gear enters the water to the time the gear is removed completely from the water. Haul back typically starts one half to one hour after the gear first enters the water. After haul back, the gear is moved to a different location, beginning a new set.

## Drift Gillnet

The ACFCMA American Shad Drift Gillnet Survey, conducted by the South Carolina Department of Natural Resources, uses drift gillnets (Figure A-17) in several SC river systems to catch, tag, and release adult shad. They use a single 5 inch mesh net which is up to 450 ft in length and 22 ft depth. The net is set adrift for 20 minutes and constantly monitored for catch.

## Trammel Net

The trammel net is a variation on the gillnet that consists of three layers of net (Figure A-18). A slack, small mesh, inner panel of netting is sandwiched between two outer layers of netting, which are taut and have a larger mesh size. The inner panel may be made of twisted monofilament or twisted nylon filament. Trammel nets are held vertically in the water by weights on the bottom (lead line), and floats on the top (float line). According to their design, ballasting and buoyancy, these nets may be used to fish near the surface, in mid-water or at the bottom, either in estuarine or marine waters.

The SEFSC uses trammel nets during the red drum stock assessment surveys in South Carolina. This trammel net is 183 meters by 2.1 meters and is fitted with a polyfoam float line and lead core bottom line.

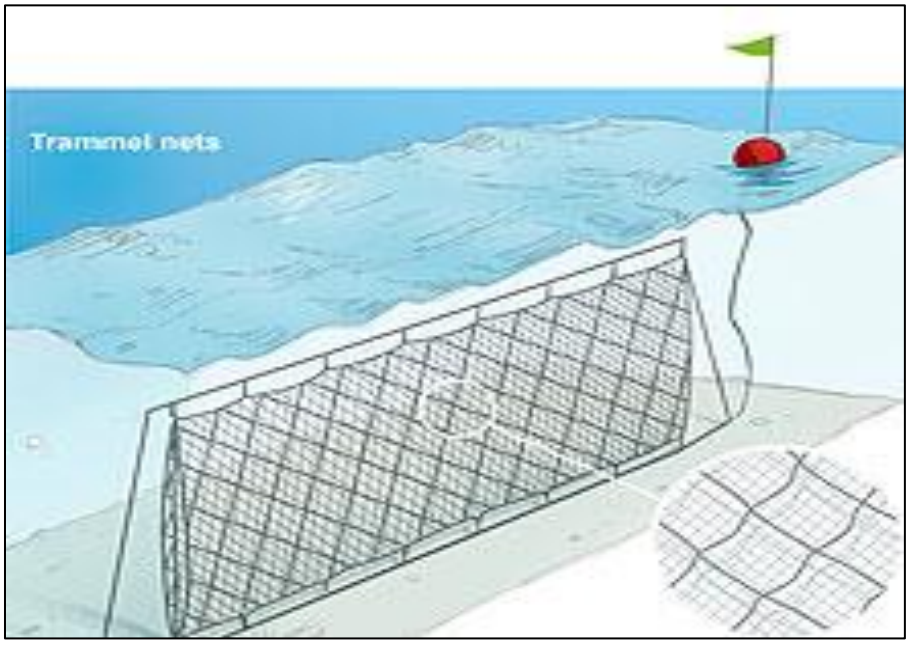


**Figure A-18. Trammel net diagram**

# 6 Traps/Pots

## Fyke Nets

A fyke net is a fish trap that consists of cylindrical or cone-shaped netting bags that are mounted on rings or other rigid structures and fixed on the bottom by anchors, ballast or stakes (Figure A-19). Fyke traps are often outfitted with wings and/or leaders to guide fish towards the entrance of the bags. The Fyke nets used by the SEFSC are constructed with wings that are 18.8 x 9 feet and bag netting of 700 micron mesh.


**Figure A-19. Fyke net diagram**

## Shrimp Cages

Shrimp cages come in various shapes and are typically constructed of mesh or metal netting and a metal or PVC frame (Figure A-20). They work by being lowered from a vessel or shore onto the bottom of the sea floor where they are baited and left for a certain amount of time and then later retrieved. Shrimp cages are used by the SEFSC during their research on shrimp survival of two different populations. The SEFSC shrimp cages are constructed of 1-inch PVC poles that were oriented vertically attached to two fiberglass hoops and wrapped in 2mm mesh netting.

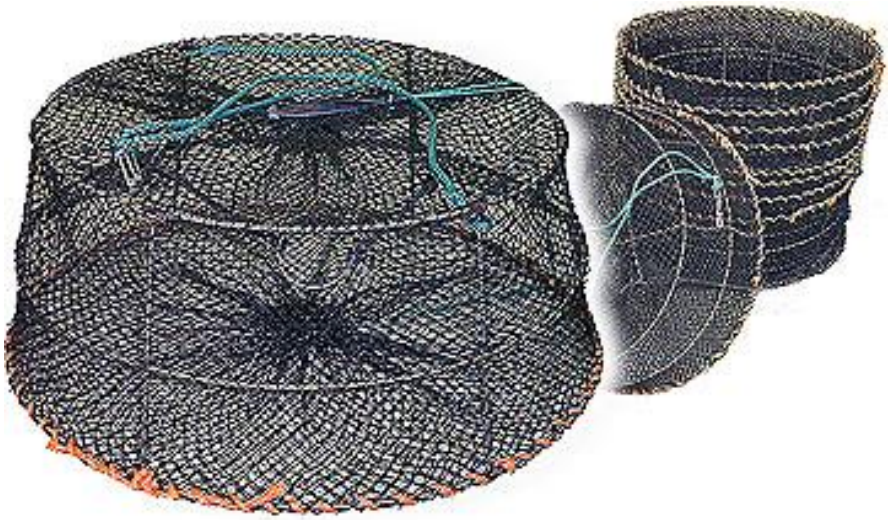

**Figure A-20. Shrimp cage**

## Eel Traps/Pots

Eel traps (Figure A-21) and pots are portable metal traps that can be constructed of wood or metal and come in various shapes. The SEFSC uses a 16 x 20 x 11 inch trap with ½-inch metal mesh. The openings for the internal funnels are 2 x 3 inches and the trap is baited with horseshoe crabs and shrimp heads.

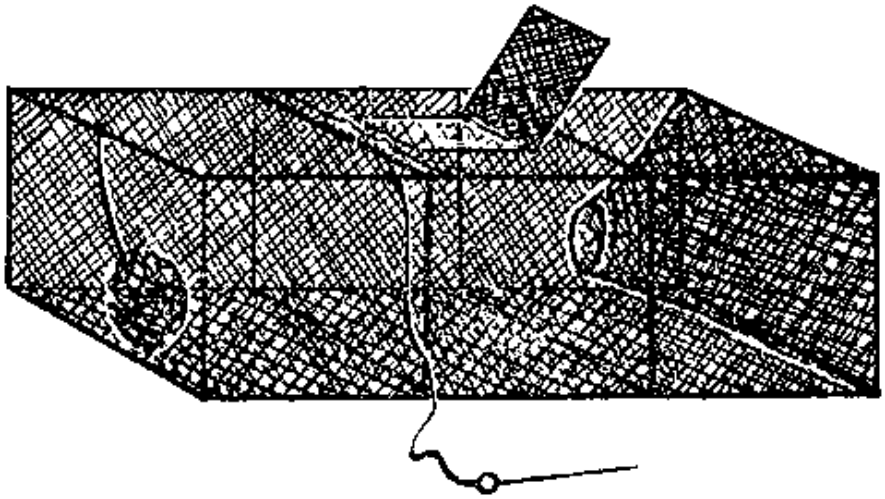

**Figure A-21. Simple eel trap**

## Throw Trap

Throw traps (Figure A-22) are open ended boxes that are tossed into the environment that is being surveyed to randomly discern a survey area. The vegetation and fauna contained in the trap are then measured and assessed. Throw traps can be made of various types of materials depending on the intended use. A throw trap is used during the SEFSC Integrated Biscayne Bay Ecological Assessment and Monitoring Project to survey epifauna and small fish in the Everglades. The throw trap is constructed of aluminum with 1 $m^2$ walls and a depth of 45 cm.

**Figure A-22. Throw trap**

## Chevron Fish Trap

Chevron fish traps are wire mesh fish cages that are used to sample fish populations (Figure A-23). The SEFSC uses several different chevron fish traps of various dimensions that are baited to attract target species.

**Figure A-23. Chevron trap**

# 7 Oceanographic Instruments

## Conductivity, Temperature, and Depth (CTD) and Water Samples

A CTD profiler measures these parameters and is the primary research tool for determining chemical and physical properties of seawater. A CTD profiler may be a fairly small device (image on the left in Figure A-24) or it may be deployed with a variety of other oceanographic sensors and water sampling devices (e.g., Niskin or go-flo bottles) in a large (1 to 2 meter diameter) metal rosette wheel (image on the right in Figure A-23). The CTD profiler is lowered through the water column on a cable, and CTD data are collected either within the device or via a cable connecting to the ship. Water sampling devices range from a bucket dropped over the side of a small boat to Niskin bottles that are triggered at discrete depths to collect a suite of water samples throughout the water column. A CTD cast takes from minutes to hours to complete depending on water depth (WHOI 2011). The data from a suite of samples collected at different depths are often called a depth profile, and are plotted with the value of the variable of interest on the x-axis and the water depth on the y-axis. Depth profiles for different variables can be compared in order to glean information about physical, chemical, and biological processes occurring in the water column.

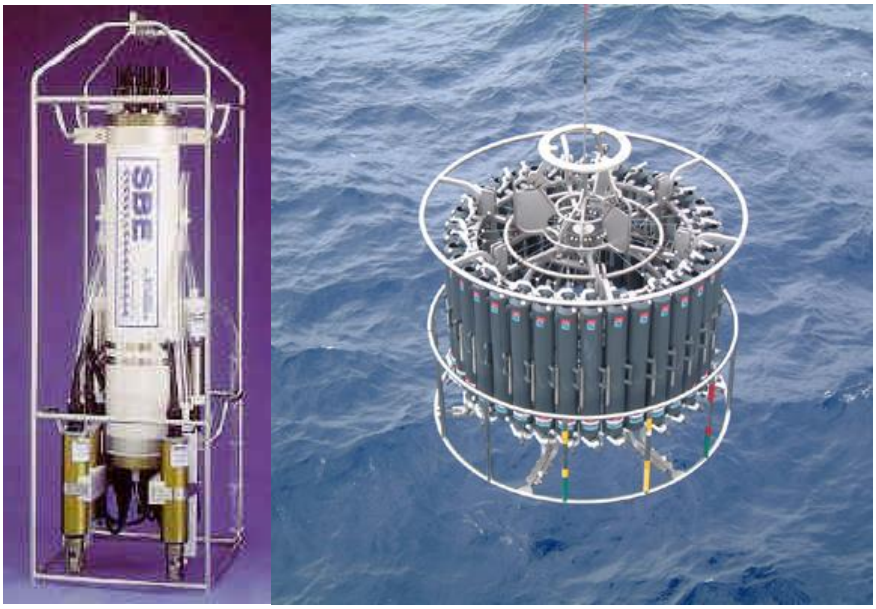


**Figure A-24. Sea-Bird 911 and CTD profiler deployment on a sampling rosette with Niskin bottles**

Credit: Sea-Bird Electronics, Bellevue WA

## Secchi Disk

A secchi disk is a round disk with alternating black and white segments that is used to measure water turbidity and transparency (Figure A-25). Typically the secchi disk is attached to a line that is marked at certain lengths to allow for depth measurement as the disk is lowered. The user lowers the secchi disk into the water until the black and white segments are indiscernible.

**Figure A-25. Secchi disk**

# 8 Remotely Operated Vehicles

## THE ROV Super Phantom S2

The Super Phantom S2 (Figure A-26) is a powerful, versatile remotely operated vehicle (ROV) with high reliability and mobility. This light weight system can be deployed by two operators and is designed as an underwater platform which provides support services including color video, digital still photography, navigation instruments, laser scaling device, lights, position information of the ROV and support ship, vehicle heading, vehicle depth, and a powered tilt platform.

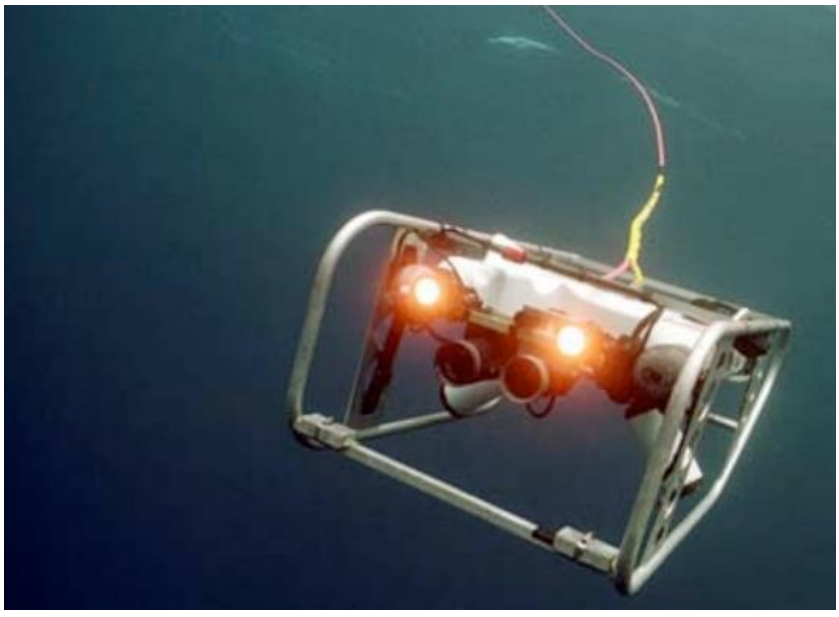

**Figure A-26. ROV Super Phantom**

## MINI ROV

The Mini ROV is used during the SEFSC Panama City Reef Fish survey to help conduct line surveys and identify cryptic and rare fish species in the Gulf of Florida. The mini ROV is equipped with color video cameras and scaling lasers.

## Underwater Scooters

Underwater scooters (Figure A-27) are used for both SEAMAP-C Queen Conch and Spiny Lobster surveys in order to help mobilize scuba divers while collecting data**.**

**Figure A-27. Underwater scooter**

# 9 Active Acoustic Sources

A wide range of active acoustic sources are used in SEFSC fisheries and ecosystem research for remotely sensing bathymetric, oceanographic, and biological features of the environment. Most of these sources involve relatively high frequency, directional, and brief repeated signals tuned to provide sufficient focus on and resolution of specific objects. Table A-1 shows important characteristics of these sources used on NOAA research vessels conducting SEFSC fisheries surveys, followed by descriptions of some of the primary general categories of sources, including all those for which acoustic takes of marine mammals are calculated in the LOA application.

**Table A-1 Output characteristics for SEFSC active acoustic sources**

| Acoustic system | Operating frequencies (kHz) | Maximum source level (dB re 1 µPa at 1 m) | Single ping duration (ms) and repetition rate (Hz) | Orientation/ Directionality | Nominal beam width (degrees) |
|---|---|---|---|---|---|
| **Simrad EK60 narrow beam echosounder** | 18, 38, 70, 120, 200, 333 | 224 | 1 ms @ 1 Hz | Downward looking | 11°@18kHz; 7°@38kHz |
| **Simrad ME70 multibeam echosounder** | 70-120 | 205 | 2 ms @ 1 Hz | Downward looking | 140° |
| **Simrad MS70 multibeam echosounder** | 70-120 | 206 | 2 ms @ 1 Hz | Downward side-looking | 0° tilt angle from vertical (horizontal looking) |
| **Simrad SX90 omni-directional multibeam sonar** | 70-120 | 206 | 2 ms @ 1 Hz | Downward omni-directional | 0°-90° tilt angle from vertical (average) |
| **ADCP Ocean Surveyor** | 75 | 223.6 | External trigger | Downward looking (30° tilt) | N/A |
| **Simrad ITI trawl monitoring system** | 27-33 | <200 | 0.05-0.5 Hz repetition rate | Downward looking | 40° x 100° |

## Multi-frequency Narrow Beam Scientific Echo Sounders (Simrad EK60)

Similar to multibeam echosounders, multi-frequency split-beam sensors are deployed from survey vessels for a variety of purposes: to acoustically map the distributions of many types of fish, estimate their abundances and biomasses, characterize their biotic and abiotic environments, investigate ecological linkages, and gather information about their schooling behavior, migration patterns, and avoidance reactions to the survey vessel. The use of multiple frequencies allows coverage of a broad range of marine acoustic survey activity, ranging from studies of small plankton to large fish schools in a variety of environments from shallow coastal waters to deep ocean basins. Simultaneous use of several discrete echosounder frequencies facilitates accurate estimates of the size of individual fish, and can also be used for species identification based on differences in frequency-dependent acoustic backscattering between species. The SWFSC uses devices that transmit and receive at six frequencies (18, 38, 70, 120, 200, and 333 kHz).

## Multi-beam Echosounders (Simrad ME70, MS70, SX90)

Multi-beam echosounders and sonars work by transmitting acoustic pulses into the water then measuring the time required for the pulses to reflect and return to the receiver and the angle of the reflected signal (Figure A-28). The depth and position of the reflecting surface can be determined from this information, provided that the speed of sound in water can be accurately calculated for the entire signal path. The use of multiple acoustic 'beams' allows coverage of a greater area compared to single beam sonar. The sensor arrays for multi-beam echosounders and sonars are usually mounted on the keel of the vessel and have the ability to look horizontally in the water column as well as straight down. Multi-beam echosounders and

sonars are used for mapping seafloor bathymetry, estimating fish biomass, characterizing fish schools, and studying fish behavior. The multi-beam echosounders used by the SEFSC emit frequencies in the 70-120 kHz range.

**Figure A-28. Conceptual image of a multi-beam echosounder**

## Acoustic Doppler Current Profiler

An Acoustic Doppler Current Profiler (ADCP) is a type of sonar used for measuring water current velocities simultaneously at a range of depths. An ADCP instrument can be mounted to a mooring or to the bottom of a boat Figure A-29). The ADCP works by transmitting "pings" of sound at a constant frequency into the water. As the sound waves travel, they ricochet off particles suspended in the moving water, and reflect back to the instrument (WHOI 2011). Sound waves bounced back from a particle moving away from the profiler have a slightly lowered frequency when they return and particles moving toward the instrument send back higher frequency waves. The difference in frequency between the waves the profiler sends out and the waves it receives is called the Doppler shift. The instrument uses this shift to calculate how fast the particle and the water around it are moving. Sound waves that hit particles far from the profiler take longer to come back than waves that strike close by. By measuring the time it takes for the waves to return to the sensor, and the Doppler shift, the profiler can measure current speed at many different depths with each series of pings (WHOI 2011).

**Figure A-29. ADCP pre-deployment**

### Trawl Monitoring Systems (Simrad ITI and FS70)

Trawl monitoring systems allow continuous monitoring of net dimensions during towing to assess consistency, maintain quality control, and provide swept area for biomass calculations. Transponders are typically located in various positions on the trawl or cables connecting the trawl to the ship. Data are monitored in real time to make adjustments in ship speed or depth of trawl to meet survey protocols.

## 10 Passive Acoustic Arrays

Passive Acoustic Monitoring is conducted by SEFSC during marine mammal surveys using two different towed hydrophone arrays. One is a hand-deployed two-element hydrophone array that is towed 200 meters behind the ship; the second is a five-element hydrophone array that can be towed up to 600 meters behind the ship (Figure A-30). The data collected can be used to determine population abundance and density of cetacean species.

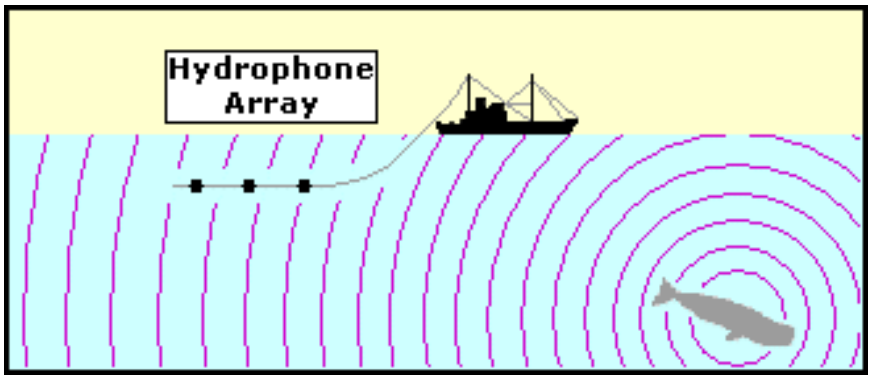


**Figure A-30. Passive acoustic array towed behind vessel**

# 11 Other Equipment Used

## Expendable Bathythermographs

The SEFSC uses an Expendable Bathythermograph (XBT) to provide ocean temperature versus depth profiles. A standard XBT system consists of an expendable probe, a data processing/recording system, and a launcher (Figure A-31). The XBT probes consist of a metal weight surrounding a temperature probe, attached to a copper wire that conducts the signal to the vessel. Probes are generally launched from the leeward side of the vessel and as far out as possible. Launching from these locations helps obtain high reliability and minimizes the chances that the fine copper probe wire will come in contact with the ship's hull which may cause spikes in the data or a catastrophic wire break. A portable shipboard data acquisition system records, processes, and interprets the data the probes collect. The XBT probes are expendable; they are not retrieved and are left on the seafloor after data collection.

**Figure A-31. Expendable XBT probe on the left; hand-held launcher on the right**

## Handheld Instruments

YSI instruments are handheld devices (several models are used) that measure dissolved oxygen, conductivity, salinity and temperature (Figure A-32). The various models consist of a micro-processor based, digital meter with an attached YSI combination conductivity and dissolved oxygen probe.


**Figure A-32. YSI 85**

## Witham Collectors

Witham collectors are used to monitor the presence of juvenile fish in estuarine nursery areas, in particular gag (*Mycteroperca microlepis*). Witham collectors consist of air conditioner filter material folded over an 18 by 18 inch PVC frame (Figure A-33). They are anchored with a single line and floated off the bottom in tidal creeks that are about 1 m deep at low tide.

**Figure A-33. Whitham collectors**

## Juvenile Lobster Artificial Shelters

Juvenile lobster shelters are used to collect specimens in shallow marine and estuarine areas. They consist of two tiers of eight concrete blocks (Figure A-34) and have been established in seagrass blowout areas (minimum of 2 to 3 meter water depth) in close proximity to fringing mangroves.

**Figure A-34. Juvenile lobster shelter**

### Ponar Dredge

A ponar dredge is used to sample materials on the sea floor. The dredge consists of two opposing semi-circular jaws that are normally held open by a trigger mechanism. The sampler is lowered to the bottom where contact with the bottom sets off the trigger and a strong spring snaps the jaws shut trapping a sample (Figure A-35).

**Figure A-35. Ponar dredge**

## 12 Cameras

### Go Pro Video Camera

Go Pro video cameras are portable and durable cameras that are easily mounted to objects in order to record things in unusual places. The SEFSC uses Go Pro cameras to document fish species during various studies by attaching them to fish traps.

### Underwater Camera Sled

The first generation of underwater camera sled or Towed Optical Assessment Device (TOAD) used for the collection of optical validation data was a MiniBAT 8820 manufactured by Guideline Instruments (Figure A-36). The MiniBAT is a sled designed to be towed at 3–10 knots while being remotely guided by an operator on the towing vessel to keep it close to the seafloor. This iteration of TOAD is configured with a single Sony DCR-PC110 Digital Video Camera in a modified Gates underwater housing. It also features a Canon Power Shot G1 Still Camera (modified by SEFSC engineers) in an Ikelite housing rated to 60 meter depth. Illumination is provided by two 500-watt underwater lights.


**Figure A-36. Camera sled**

## 4-Camera Array and 2-Camera Array

The 4- and 2-camera arrays used by the SEFSC consist of color cameras paired with black-and-white stereo cameras set inside an aluminum housing (Figure A-37). Before being lowered from the boat the arrays are baited with squid and then attached to a float by a line.

**Figure A-37. Camera array**

# 13 SEFSC Vessels Used for Survey Activities

The SEFSC and its research partners use a variety of different types and sizes of vessels to meet their needs and objectives. Vessels are also sometimes chartered from the commercial industry or other institutions/agencies. Vessels vary in size from small fishing vessels (U.S. Coast Guard [USCG] Class A – up to 16 ft. and Class I – 16 to <26 ft.), medium vessels (USCG Class II – 26 to <40 ft. and Class III – 40 to 65 ft.), USCG Small Research Vessel (R/V) (>65 ft. and <300 gross tons) and USCG Research Vessel (R/V) (>65 ft. and >300 gross tons). Several Motor Vessels (M/V) >65 feet and USCG Research Vessels are also chartered and used by partner agencies. Since the actual vessel can change frequently, especially for small vessels, only vessels >65 ft used by the SEFSC and partners and named NOAA vessels are described here.

## R/V *Georgia Bulldog*

The University of Georgia research vessel R/V *Georgia Bulldog* (Figure A-38) was built in 1977 in St. Augustine Florida and is currently used for research on improving trawl gear as well as sea turtle research. The R/V *Georgia Bulldog* is rigged for various types of fishing that includes: shrimp trawlers, bottom trawl, longline, handline, dredges and traps. The vessel is 72-ft wooden-hull boat that is powered by a 6-cylinder Caterpillar 335 hp diesel engine. It can sleep a total of eight people. Special research equipment aboard the R/V *Georgia Bulldog* includes depth recorders, surface water temperature gauge, three VHF radios, two GPS units, plotter for navigation, color fish finding depth recorder, two radars, automatic pilot, real-time underwater video system, and two computers. The homeport for the R/V *Georgia Bulldog* is Brunswick, Georgia.


**Figure A-38. R/V *Georgia Bulldog***

## R/V *Lady Lisa*

The R/V *Lady Lisa* is a research vessel operated by the South Carolina Department of Natural Resources (Figure A-39). The R/V *Lady Lisa* is 75 feet in length with a wooden hull and was built in 1980. It is powered by a 415 HP, 12 cylinder Caterpillar engine and is capable of towing two 80-ft trawls. The vessel has accommodations for three crew members and eight scientists as well as dry storage space for gear and cold storage space for samples. The R/V *Lady Lisa* is the primary sampling platform for several state and federal projects, working mostly in near coastal waters between Cape Hatteras, NC and Cape Canaveral, Florida.

**Figure A-39. R/V *Lady Lisa***

## NOAA Ship *Gordon Gunter*

The *Gordon Gunter* (Figure A-40) primarily serves the NMFS Pascagoula Laboratory in Mississippi. The *Gordon Gunter* is a 224-ft. multi-use platform. It is equipped with a thermosalinograph, CTD, fluorometer, and other oceanographic instruments that monitor atmospheric and oceanic conditions while traveling. A variety of research gears are deployed from the vessel including stern trawling, longlining, plankton tows, and dredging. The *Gordon Gunter* operates in all three SEFSC research areas.


**Figure A-40. NOAA Ship *Gordon Gunter***

## NOAA Ship *Nancy Foster*

The *Nancy Foster* (Figure A-41) is a 187-ft research vessel that operates in all three SEFSC research areas. The *Nancy Foster* is used in habitat and fauna characterization in the nation's National Marine Sanctuaries as well as pollution assessments, bathymetric surveys, physical and chemical oceanography studies, maritime heritage surveys, and pollution assessments. On board equipment includes two cranes, A-frame, J-frame and two winches. Special research equipment includes wet and dry laboratories, computers for data acquisition and analysis, and instruments for obtaining oceanographic and atmospheric data. The ship also carries four different launches, ranging from 17-ft rigid hull inflatable boats to a 23-ft aluminum boat for diving and oceanographic operations in shallow water.


**Figure A-41. NOAA Ship *Nancy Foster***

## NOAA Ship *Oregon II*

The *Oregon II* is a 170-ft NOAA research vessel that is used for living marine resource studies in support of the SEFSC Pascagoula Laboratory (Figure A-42). The vessel is operated in all three SEFSC research areas and has several types of fishing and research gear used on board that includes: a double-rigged shrimp trawl, longline winch, fish trap, dredge, electronic fish detection equipment, environmental sensors, and electronics equipment.


**Figure A-42. NOAA Ship *Oregon II***

## NOAA Ship *Pisces*

The *Pisces* is a 208-ft NOAA research vessel capable of carrying a crew of 21 and up to 15 scientists (Figure A-43). The *Pisces* is a newly constructed fisheries research vessel launched in 2007 and commissioned in 2008. The vessel is operated in all three SEFSC research areas and has multiple types of fishing and research gear available. A special feature of the new ship is its quiet hull design that minimizes the sound transmitted underwater, making this ship ideal for surveying marine life.


**Figure A-43. NOAA Ship *Pisces***

## NOAA Ship *Thomas Jefferson*

The *Thomas Jefferson* is a 208-ft research vessel that is operated in all three SEFSC research areas (Figure A-44). The vessel is equipped with surveying gear such as GPS, side-scan and multibeam sonar-imaging, and state-of-the-art computers. On-board equipment is used to conduct hydrographic surveys for udpdating NOAA's nautical charts.


**Figure A-44. NOAA Ship *Thomas Jefferson***

## NOAA Vessel R/V *Harold B*

The R/V *Harold B* (Figure A-45) is a 36-foot ex-Navy aluminum hulled dive boat stationed at the NOAA Fisheries Panama City Laboratory for use in the coastal waters of northwest Florida. The vessel is a 1988 heavily built Munson hull in good condition powered by two John Deere 225 hp diesel engines, vessel also has a Kohler 8EOZ generator. The vessel can operate in inshore and offshore waters no greater than 125 miles from the nearest land. The vessel can, and will, carry up to eight persons, including the vessel operator for voyages up to 12 hours away from port. The vessel is configured for fishing operations, traps, longlines, diving, use of remotely operated vehicles (ROV). Deck modifications include the addition of a davit and hydraulic pot hauler on the aft deck to be used for lifting traps and sampling gear. The vessel is restricted to day time operations only and is restricted from performing restricted ability to maneuver operations at night and during periods of limited visibility. Special Equipment includes GPS (2), Fish/Depth finder (2), Radar, DSC VHF (2), SSB (1), EPIRB, SART and an on board computer w/ Nobeltec navigation software.


**Figure A-45. NOAA Vessel R/V *Harold B***

## UNOLS R/V *Savannah*

The R/V *Savannah* (Figure A-46) is a multi-use 92' oceanographic and fisheries research vessel operated by the Skidaway Institute of Oceanography, homeported in Savannah, Georgia, and is a member of the University National Oceanographic Laboratory System (UNOLS) fleet. The R/V *Savannah* can sleep a total of 20 people and is used for biological, chemical, physical, and geological oceanographic studies in estuarine and continental shelf waters throughout the southeastern US Atlantic and Gulf Coasts. It can deploy trawls, longlines, handlines, dredges, traps, buoys, landers, and autonomous underwater vehicles, and is equipped with motion-compensated depth recorders, an acoustic doppler current profiler, CTD, crane, A-frame, pot hauler, flow-through systems, and a network of on-board ship sensors.

**Figure A-46. UNOLS R/V *Savannah***

## R/V *Tommy Munro*

The R/V *Tommy Munro* (Figure A-47) is a 97.5-ft research vessel owned and operated by the University of Southern Mississippi's Gulf Coast Research Laboratory. It has a range of 2,500 nautical miles and berthing for ten scientists and six crew. The vessel is driven by twin GM V12-71 engines each capable of 300 hp @ 1,800 RPM. Electrical power is provided by 2 GM-4-71 diesel-powered generators supplying 50 kw (208/120V AC). Hydraulic power is obtained from one 15 GPM @ 2000 psi system and one 6 GPM @ 2,000 psi system. The vessel is capable of a multitude of scientific collection applications, including trawling, long-lining, plankton sampling, water collection and CTD profiles, benthic grabs, fish/crab trap deployment/retrieval, sensor deployment/retrieval, and mapping.


**Figure A-47. R/V *Tommy Munro***

## NOAA Vessel R/V *Mokarran* F2504

The Research Vessel *Mokarran* F2504 (Figure A-48) is a 25 foot Boston Whaler with a fiberglass hull that is used for the GULFSPAN Survey and dive operations in support of the SEFSC Panama City Laboratory. It is currently configured for in- and nearshore fishing operations, including gillnetting and longlining. The vessel can carry up to 5 people, including the vessel operator, and operates in Florida state waters no greater than 2 miles from shore. The vessel has been modified from its original design by the addition of a permanent aluminum frame and canvas top. It is equipped with a depth recorder, surface water temperature gauge, GPS plotter for navigation, electronic fish detection equipment, VHS, and an auto-release EPIRB. The home port for the R/V *Mokarran* is Panama City, Florida.


**Figure A-48. NOAA Vessel R/V *Mokarran* F2504**

## NOAA Vessel R/V *Caretta*

The R/V *Caretta* is a 58 ft steel-hull NOAA research vessel that is used for living marine resource studies in support of the SEFSC Pascagoula Laboratory (Figure A-49). The vessel can sleep a total of six people. A variety of research gear deployed from the vessel includes: shrimp trawls with otter boards or skimmers, longlines, handlines, bandit reels, traps, CTD'S, camera arrays, It is equipped with depth recorders, surface water temperature gauge, and plotter for navigation, CTD winch, small crane. The homeport for the R/V *Caretta* is Pascagoula, MS. The R/V *Caretta* operates in state and federal waters from western Louisiana through the west Coast of Florida.


**Figure A-49. NOAA Vessel R/V *Caretta***

## R/V *Bellows*

The R/V *Bellows* (Figure A-50) is owned by the State of Florida and is operated by the Florida Institute of Oceanography on behalf of the State University System. It is designated and certified as an Oceanographic Research Vessel by the US Coast Guard. The R/V *Bellows* is 71-ft long and has a 20-ft beam. The vessel can accommodate 10 scientists and there is 275 sq. ft of deck space and a 185 sq. ft wetlab/drylab air conditioned area. The vessel is equipped with hydraulic winches to operate CTDs, small trawls or bottom dredges. The vessel is operated out of St. Petersburg, FL.

**Figure A-50. R/V *Bellows***

## R/V *Weatherbird II*

The R/V *Weatherbird II* (Figure A-51) is owned by the University of South Florida for use through the Florida Institute of Oceanography. The vessel was built in 1982, by Bosarge Marine in Bayou La Batre, AL. This vessel is equipped with advanced laboratories, oceanographic devices and sensor technology designed to enable scientists and students to study and learn about various aspects of the ocean's biological, chemical, geological and physical characteristics. The R/V *Weatherbird II* is 115-ft long and has a 28-ft beam and cruises at 10kts. The vessel can accommodate 13 scientists and 6 crew. There is 780 sq. ft. deck space and a 200 sq. ft wetlab. The vessel is equipped with hydraulic winches for CTDs and trawls. The vessel is operated out of St. Petersburg, FL.


**Figure A-51. R/V *Weatherbird II***

## R/V *Apalachee*

The R/V *Apalachee* (Figure A-52) is owned and operated by the Florida State University Coastal and Marine Laboratory. The vessel was built by Geo Shipyard, Inc. in New Iberia, LA in 2013. It was designed to work in coastal and offshore waters, allowing scientists and students to conduct research on the ocean's biological, chemical, geological and physical characteristics that affect global and coastal oceans. The R/V *Apalachee* is 65-ft. long and has a 22-ft beam and cruises at 12 – 16kts. The vessel can accommodate 4 – 6 scientists and 2 crew. There is 780 sq. ft deck space and 200 sq. ft wetlab and 200 sq. ft. drylab space. The vessel has a winch and A-frame on the stern and can operate small trawls. The vessel is operated out of St. Teresa, FL.


**Figure A-52. R/V *Apalachee***

## R/V *Palmetto*

The 110 foot R/V *Palmetto* is South Carolina Department of Natural Resources' offshore research vessel (Figure A-53). Made of steel and powered by twin 550 HP diesel engines, the vessel generally conducts scientific research from Cape Lookout, NC to Palm Beach, Florida and out to over 200 miles. The vessel operates around the clock for up to 10 days at sea with a crew of 6, and has berthing for 9 scientists. Bridge electronics include GPS integrated into computerized navigation software, satellite communications including email capabilities, as well as standard radar, radios, depth-sounders, air and sea temperature sensors, etc. The air-conditioned wet lab has its own navigation electronics and computer facilities. On deck equipment include a seawater ice maker, marine crane, A-frame, winch, and hydraulic pot hauler allowing deployment and retrieval of a wide variety of research instruments and sampling gears. (https://www.dnr.sc.gov/marine/mrri/vessels/palmetto.html)

**Figure A-53. R/V *Palmetto***

## R/V *Cape Hatteras*

The R/V *Cape Hatteras* is a 135 foot steel-hull research vessel owned and operated by Cape Fear Community College (Figure A-54). The vessel was built in 1981 by Atlantic Marine Ship Builders, Fort George Island. FL and is available for oceanographic research use through charters by outside agencies. The vessel is capable of carrying a crew of 8 and up to 19 scientists and can endure 25 days at sea. The vessel has multiple types of fishing and research gear available including a trawl winch, CTD winch, Markey portable electric winch, J-frame and stern A-frame.


**Figure A-54. R/V *Cape Hatteras***

## M/V *Spree*

The M/V *Spree* (Figure A-55) is a 100 foot aluminum crew boat refit for open-ocean diving owned and operated by Spree Expeditions Inc. The vessel is capable of carrying 22 passengers, 2 trip leaders, and up to 8 boat crew, for a maximum of 32 people aboard and can endure 25 days at sea. The M/V *Spree* is powered by three 12V71 Detroit Diesel engines and runs at a top speed of approximately 16 knots. The vessel has multiple types of fishing and research gear available including a lifting Davit 500 lb. capacity, towing Davit 1,000 lb. capacity, pot Hauler 800 lb. capacity, Hydraulic Crane 7,000 lb. capacity, NAVTEX Furuno NX-300, autopilot Simrad AP-45, and Satellite: Thrane and Thrane VOIP.

**Figure A-55. M/V *Spree***

## R/V *Pelican*

The 116 ft. R/V *Pelican* (Figure A-56) was designed and outfitted to conduct a variety of oceanographic research missions. The R/V *Pelican* successfully conducts scientific trawling, MOCNESS trawls, large box core sampling, thirty-foot piston cores, shallow seismic surveys, current meter array and benthic boundary array deployment and recovery. The R/V *Pelican* has also successfully conducted plankton sampling, hydrographic casts with CTD-rosette system, ADCP sampling and underway collection sampling (SCS) and with towed water sampling systems. The vessel is owned by the State of Louisiana, operated by Louisiana Universities Marine Consortium (LUMCON) and homeported in Cocodrie, Louisiana. The vessel is operated as an Research Vessel as designated by the USCG. The vessel is available for legitimate research and education programs of Consortium members, state and federal agencies, other nonprofit groups, and oceanographic industries. The R/V *Pelican* operates primarily in the Gulf of Mexico but has been conducting research as far north as Canada and as far south as Trinidad.


**Figure A-56. R/V *Pelican***

## R/V *Point Sur*

The 135 ft. R/V *Point Sur* (Figure A-57) was also designed, built and outfitted in 1980 to conduct a variety of oceanographic research missions. The vessel is owned by the University of Southern Mississippi and is managed and operated by LUMCON. The R/V *Point Sur* successfully conducts scientific trawling, MOCNESS trawls, large box core sampling, shallow seismic surveys, current meter array and benthic boundary array deployment and recovery. The vessel has also successfully conducted multiple types of mooring operations, plankton sampling, ADCP sampling, hydrographic casts with CTD-rosette system and underway water collecting sampling systems (SCS). The vessel is homeported in Gulfport, Mississippi at the Port of Gulfport. The vessel is operated as an Research Vessel as designated by the USCG. The vessel is available for legitimate research and education programs of LUMCON and USM members, state and federal agencies, other nonprofit groups, and oceanographic industries.


**Figure A-57. R/V *Point Sur***

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